MODEL ANSWERS

S.Y.B.Sc. in Biotechnology - Biochemistry

(Choice Based)

65594

Q.P. Code:

2 ½ Hours

Total Marks: 75

1. Attempt **all** questions.
2. **All questions** carry **equal** marks.
3. Draw **neat labeled diagrams** wherever necessary.
4. Use of **log tables** and **non-programmable calculator** is **allowed.**
5. For **Q 2, Q 3 and Q 4** attempt A and B **OR** C and D.

Q 1 **Do as directed (Any fifteen)** **15**

1. Precursor amino acid for biosynthesis of serotonin is **tryptophan.**
2. Synthesis of glucose from non-carbohydrate precursors is accomplished by a pathway called **gluconeogenesis**
3. The number of NADPH produced when one molecule of Glucose 6-phosphate completes oxidative phase of HMP shunt is **2**
4. Give one example of glucogenic amino acid – **valine, alanine, methionine, asparagine, glutamate, aspartate, histidine, proline, cysteine, arginine, glutamine, serine, glycine**
5. Name one enzyme of glyoxalate cycle that is not present in vertebrates – **malate synthase, isocitrate lyase**
6. Name the organ in which urea is produced in humans - **liver**
7. Give one example of energy rich compound – **ATP, Acetyl CoA, PEP, Creatine phosphate**
8. State true /false: Non-oxidative deamination of histidine releases ammonia - **True**

Write the equation for the reaction catalysed by following enzymes:-

9. Citrate synthase **Acetyl-CoA + Oxaloacetate → Citrate**
10. Glutamate dehydrogenase **Glutamate → α-ketoglutarate**

Name the enzyme that catalyses the conversion of following reactions:-

11. Arginine to ornithine **Arginase**
12. Glyceraldehyde 3-phosphate to 1,3-bisphosphoglycerate **Glyceraldehyde 3-phosphate dehydrogenase**
13. The reactions of ketone body formation occur in the matrix of ..... .

a. kidney mitochondria b. **liver mitochondria**

c. kidney cytosol d. liver cytosol

14. The absence of Hypoxanthine-Guanine Phosphoribosyl Transferase activity is observed in _____.

a. **Lesch-Nyhan syndrome** b. Zellweger syndrome

c. Refsum's disease d. X-linked adrenoleukodystrophy

15. _____ are lipid-binding proteins in the blood which transports triacylglycerols, phospholipids, cholesterol, and cholesteryl esters between organs.

a. **Apolipoproteins** b. Lipases

c. Carboxylases d. Chylomicrons

16. The fatty acyl group is enzymatically transferred from Carnitine to intra-mitochondrial Coenzyme A by _____.

a. **Carnitine Acyltransferase II** b. Lipase,

b. Carboxylase, d. Carnitine Acyltransferase I

17. Propionyl-CoA is first carboxylated to form the D stereoisomer of methyl malonyl-CoA by .....

a. **Propionyl-CoA Carboxylase** b. Methylmalonyl-CoA Epimerase,

c. Methylmalonyl-CoA Mutase. d. Thiolase

18. Branched fatty acids are catabolized in peroxisomes of animal cells by

a. ω oxidation b. **α oxidation** c. β oxidation d. μ oxidation

19. Phosphorylation of ..... permits hormone sensitive lipase access to the surface of the lipid droplet

a. **perilipin** b. triacylglycerols c. carnitine d. acyl-CoA

20. The overall equation of Palmitoyl-CoA beta oxidation is:

Palmitoyl-CoA + 7CoA + 7FAD + 7NAD$^+$ + 7H_2O

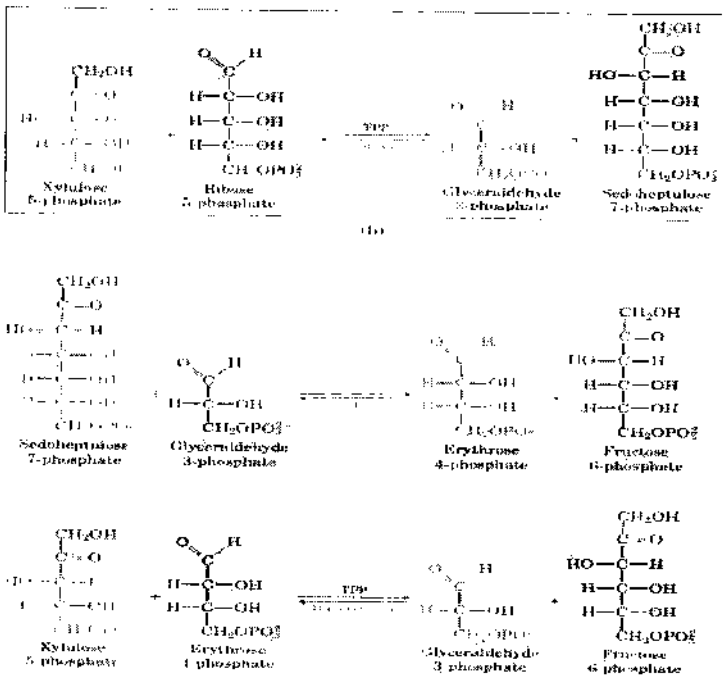
$\longrightarrow$ _____ + 7$FADH_2$ + 7NADH + 7H^+

a. **8 Acetyl-CoA** b. 7 Acetyl-CoA

c. 14 Acetyl-CoA d. 16 Acetyl-CoA

Q. 2 A Discuss the reactions involved in the non-oxidative phase of the pentose phosphate pathway **08**

3



Q. 2 B Explain the regulation of glycolysis pathway **07**

Phosphofructokinase (PFK) is the most important regulatory enzyme in glycolysis. This enzyme catalyses the rate limiting committed step. PFK is an allosteric enzyme regulated by allosteric effectors. ATP ,citrate and H+ ions (low pH) are the most important allosteric inhibitors, whereas, fructose2 ,6-bisphosphate, ADP, AMP
and Pi are the allosteric activators.
Role of fructose 2,6-bisphosphate in glycolysis:
Fructose2 ,6-bisphosphat(eF 2,6-BP)is considered to be the most important regulatory factor (activator) for controlling PFK and, ultimately, glycolysis in the liver. F2,6-BP is synthesized from fructose 6-phosphate by the enzyme phosphofructokinase called PFK-2(PFK-1 is the glycolytic enzyme). F2,6-BP is hydrolysed by
fructose 2,6-bisphosphatase. The function of synthesis and degradation of F2,6-BP is brought out by a single enzyme (same polypeptide with two active sites) which is referred to as bifunctional enzyme. In fact, the combined name of phosphofructokinase-2/
fructose2 ,6-bisphosphatase is used to refer to the enzyme that synthesizes and degrades F 2,6-BP. The activity of PFK-2 and fructose 2,6- bisphosphatase is controlled by covalent modification which, in turn, is regulated by cyclic AMP (cAMP is the second messenger for certain hormones). Cyclic AMP brings about
Dephosphorylation of the bifunctional enzyme, resulting in inactivation of active site responsible for the synthesis of F2,6-BP but activation of the active site responsible for the hydrolysis of F2,6-BP

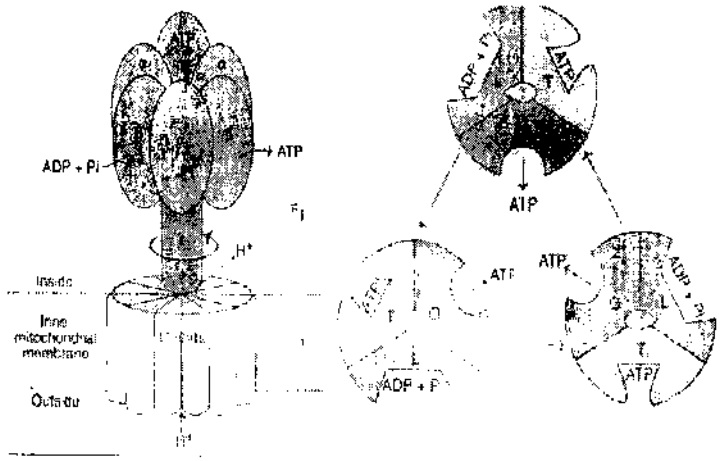
Hexokinase is inhibited by glucose 6-phosphate. This enzyme prevents the accumulation of glucose 6-phosphate due to product inhibition.
Pyruvate kinase also regulates glycolysis. This enzyme is inhibited by ATP and activated by F1,6-BP. Pyruvate kinase is active (a) in dephosphorylated state and inactive (b) in phosphorylated state.
Inactivation of pyruvate kinase by phosphorylation is brought about by cAMP-dependenpt roteink inase

OR

Q. 2 C With the help of a neat labelled diagram explain the structure and mechanism of rotary motor model for ATP generation **08**

Rotary Motor model for ATP generation:-

Paul Boyer in 1964 proposed (Nobel Prize, 1997) that a conformational change in the mitochondrial membrane proteins leads to the synthesis of ATP. The original Boyer hypothesis, now considered as rotary motor/engine driving model or binding change model, is widely accepted for the generation ATP. The enzyme ATP synthase is FoFl complex (of complex V). The Fo subcomplex is composed of channel protein 'C' subunits to which Fl-ATP Synthase is attached. F1- ATP synthase consists of a central subunit surrounded by alternating α and subunits. In response to the proton flux, the γ subunit physically rotates. This induces conformational changes in the β3 subunits that finally lead to the release of ATP. According to the binding change mechanism, the three β subunits of F1-ATP synthase adopt different conformations. One subunit has open (O) conformation, the second has loose (L) conformation while the third one has tight (T) conformation. By an unknown mechanism, protons induce the rotation of γ subunit, which in turn induces conformation changes in β subunits. The substrates ADP and Pi bind to β subunit in L-conformation. The L site changes to T conformation,and this leads to the synthesis of ATP. The O site changes to L conformation which binds to ADP and Pi. The T site changes to O conformation, and releases ATP. This cycle of conformation changes of B subunits is repeated. And three ATP are generated for each revolution. It may be noted that the ATP release in O conformation is energy dependent (and not ATP synthesis and very crucial in rotary motor model for ATP generation. The enzyme ATP synthase acts as a proton driving motor, and is an example of rotary catalysis. Thus, ATP synthase is the world's smallest molecular motor.



Q. 2 D Describe the glyoxalate cycle and add a note on its significance **07**

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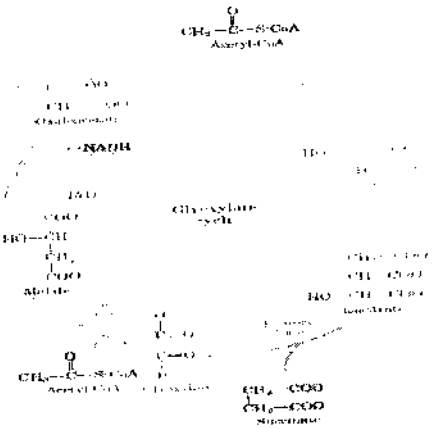
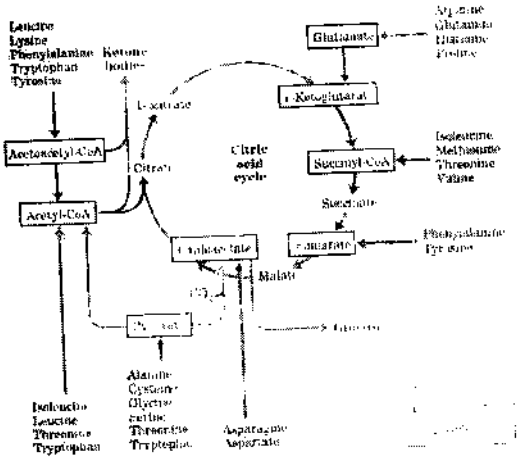


Significance - Glyoxalate cycle serves as a mechanism for converting acetate to carbohydrates. In plants and other organisms acetate can serve as an energy rich fuel and as a source of PEP for carbohydrate synthesis.

Q. 3 A Justify: Amino acids are degraded to metabolites that integrate into Krebs cycle **08**



Q. 3 B Discuss the metabolic disorders associated with defects in urea cycle. **07**

Defect	*Enzyme involved*
Hyperammonemia type I	Carbamoyl phosphate synthase I
Hyperammonemia type II	Ornithine transcarbamoylase
Citrullinemia	Argininosuccinate synthase
Argininosuccinic aciduria	Argininosuccinase
Hyperargininemia	Arginase

OR

Q. 3 C Describe the mechanism of transamination of amino acids. **08**

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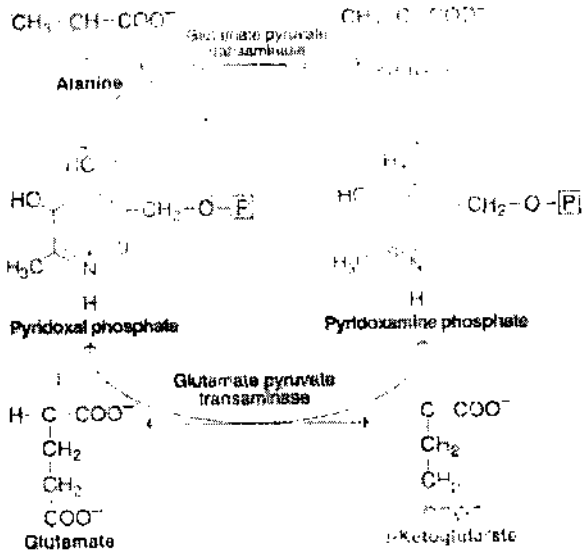
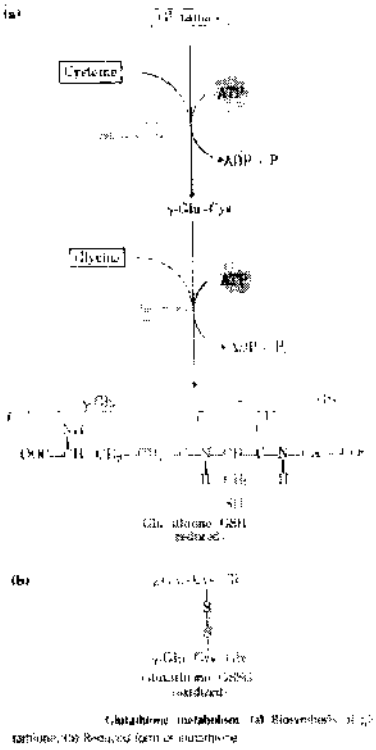


Q. 3 D Explain the structure of glutathione and state its significance **07**



Significance:- Glutathione helps to maintain the sulfhydryl groups of proteins in the reduced state and the ion of heme in the ferrous state. It helps in free radical seavenging

Q. 4 A Describe beta oxidation of saturated fatty acids. **08**

First step: Catalyzed by three isozymes of acyl-CoA dehydrogenase, each specific for a range of fatty-acyl chain lengths: very-long-chain acyl-CoA dehydrogenase (VLCAD), acting on fatty acids of 12 to 18 carbons; medium-chain (MCAD), acting on fatty acids of 4 to 14 carbons; and short-chain (SCAD), acting on fatty acids of 4 to 8 carbons. Transferred to FAD, and the reduced form of the dehydrogenase immediately donates its electrons to an electron carrier of the mitochondrial respiratory chain, the

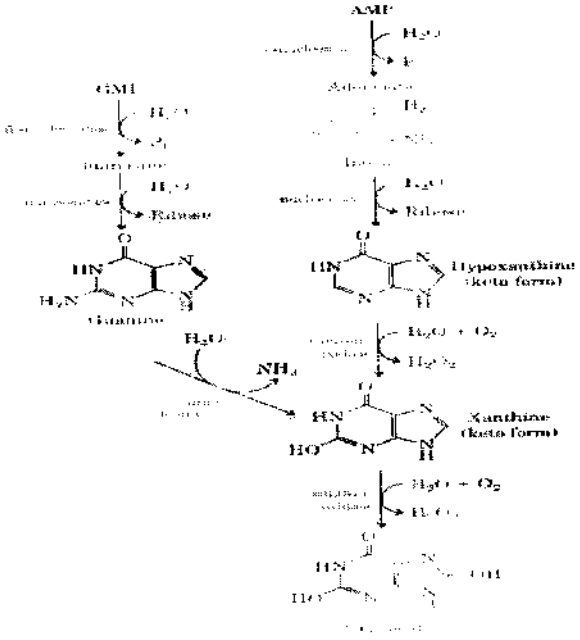
electron-transferring flavoprotein (ETF).

Second step: Water is added to the double bond of the *trans*-2-enoyl-CoA to form the L stereoisomer of -hydroxyacyl-CoA (3-hydroxyacyl-CoA). This reaction, catalyzed by enoyl-CoA hydratase.

Third step: L--hydroxyacyl-CoA is dehydrogenated to form -ketoacyl-CoA, by the action of -hydroxyacyl-CoA dehydrogenase. The NADH formed in the reaction donates its electrons to NADH dehydrogenase, an electron carrier of the respiratory chain, and ATP is formed from ADP as the electrons pass to O_2.

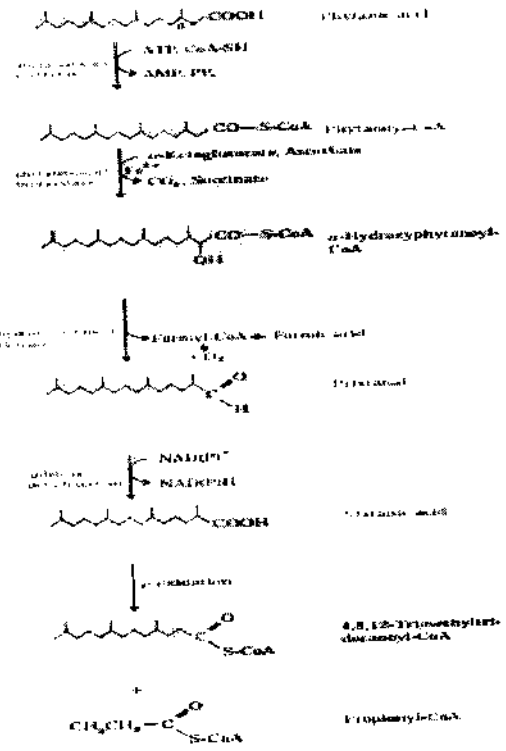
Fourth step: Catalyzed by **acyl-CoA acetyltransferase,** more commonly called thiolase, which promotes reaction of - ketoacyl-CoA with a molecule of free coenzyme A to split off the carboxyl-terminal two-carbon fragment of the original fatty acid as acetyl-CoA. The other product is the coenzyme A thioester of the fatty acid, now shortened by two carbon atoms.

Q. 4 B Give detailed account of Purine catabolism. **07**

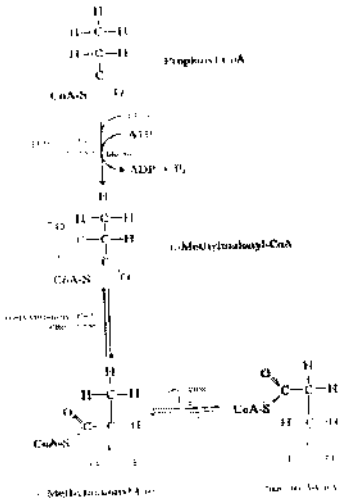


OR

Q. 4 C Elaborate reactions involved in the α-oxidation of a branched-chain fatty acid. **08**



Q. 4 D Explain three additional reactions involved in complete oxidation of odd number fatty acid. **07**



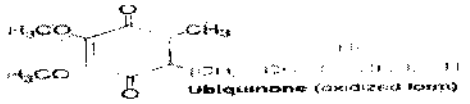
Q. 5 Write Short notes on **any three** of the following **15**

a. Metabolic disorders associated with pentose phosphate pathway

- Favism
- Glucose 6-phosphate dehydrogenase (G6PD) deficiency
- Wernicke-Korsakoff syndrome

b. Role of coenzyme Q in ETC

Coenzyme Q is also known as ***ubiquinone*** since it is ubiquitous in living system. It is a quinone derivative with a variable ***isoprenoid*** side chain. The mammalian tissues possess a quinone with 10 isoprenoid units which is known as coenzyme Q_{10} (C_{59} ...



Ubiquinone (oxidized form)

Coenzyme Q is a lipophilic electron carrier. It can accept electrons from $FMNH_2$ produced in the ETC by NADH dehydrogenase or $FADH_2$ produced outside ETC (e.g. succinate dehydrogenase, acyl CoA dehydrogenase).

Coenzyme Q is not found in mycobacteria. Vitamin K performs similar functions as coenzyme Q in these organisms. Coenzyme Q has no known vitamin precursor in animals. It is directly synthesized in the body. (Refer cholesterol biosynthesis. ***Chapter 14***)

c. Non-oxidative deamination.

Some amino acids can be deaminated to liberate NH without undergoing oxidation and they require special enzymes like:

Serine
Threonine
Homoserine
—Dehydratase→ NH_3 + ...

Cysteine —Desulfhydrases→ Pyruvate + NH_3 + H_2S

Histidine —Histidase→ Urocanate + NH_3

d. Role of Cyclic AMP -dependent protein kinase (PKA) in triacylglycerol mobilization

- Cyclic AMP-dependent protein kinase (PKA) phosphorylates perilipin A. and the phosphorylated perilipin causes **hormone-sensitive lipase** in the cytosol to move to the lipid droplet surface, where it begin hydrolyzing diacylglycerols to free fatty acids and glycerol.
- PKA also phosphorylates hormone-sensitive lipase, doubling or tripling its activity

e. ω- oxidation of fatty acid.

The oxidation of fatty acids in the endoplasmic reticulum. This alternative to Beta *oxidation* begins with oxidation of the carbon most distant from the alpha carbon; the (omega) carbon. The substrate is usually a medium-chain fatty acid.

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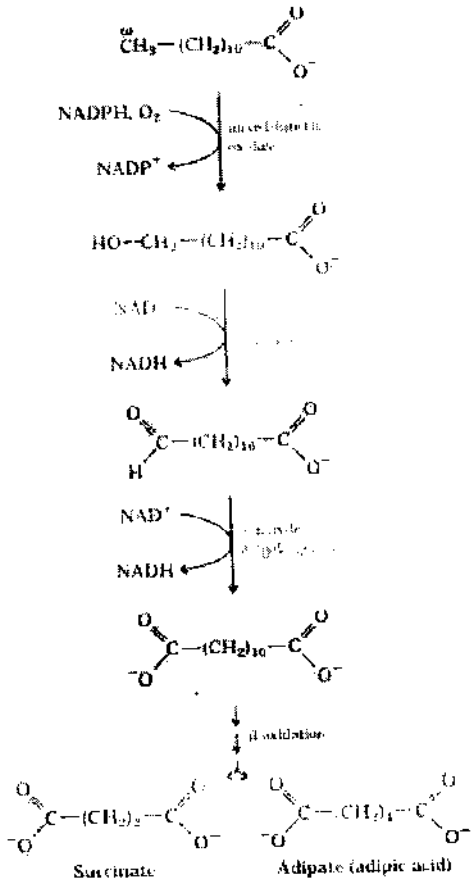
NADPH, O2
NADP+
NADH
NAD+
NADH
β-oxidation
Succinate
Adipate (adipic acid)